Is the Spear of Istiophorid Fishes Used in Feeding?[1]

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THE SPORT OF ANGLING for spearfishes—the several marlins and sailfishes of the family Istiophoridae—has fostered many books and articles on the behavior of these large fishes. The swordfish, *Xiphius gladius* Linnaeus, comprising the family Xiphiidae, also commands a very considerable following among saltwater anglers and is the subject of an extensive literature. Certain beliefs have arisen concerning the behavior and habits of the fishes comprising these game fish families, particularly as to their methods of obtaining food. It seems worthwhile to attempt now an evaluation of the accumulated evidence. Only the true spearfishes, particularly the marlins, will be considered in detail. The broadbill swordfish will be mentioned only occasionally, and the conclusions reached do not necessarily pertain to this fish.

Angling lore is replete with reports of such fishes stunning prey and trolled fish baits with a blow of the spear before devouring them. The time-honored belief that the spearfishes possess their spears for the express purpose of striking or stabbing prey, however, may now be questioned. Recently accumulated evidence indicates that such fish can exist quite readily without a spear to aid in obtaining food. Other evidence has cast some doubt as to whether the spear is at all commonly employed in such a manner.

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RECORDED OBSERVATIONS OF FISH WITHOUT SPEARS

Moore (1950) reported on a spearless black marlin, *Makaira mazara* (Jordan and Snyder), that was landed at a commercial fish market in Honolulu, Hawaii, without indicating the length of stub remaining. The nature of the wound indicated some time lapse since the loss. The specimen weighed 545 lbs. and was judged equal in physical condition to normal fish of the same species.

Mr. Vernon E. Brock, Director, Division of Fish and Game, Hawaii, in correspondence reports ". . . a spear removed from a marlin which has been broken with the remaining part that is spiraled like a corkscrew. The fish from which the spear was taken was, according to the fishermen, normal in all respects."

Morrow (1951) reported that a 172-lb. striped marlin, *Makaira mitsukurii* (Jordan and Snyder), taken with sporting tackle and trolled bait at Otehei Bay, New Zealand, had the spear broken off on a long slant reaching from several inches behind the mandible tip to within a few inches of the eye. The break had completely healed and was well covered with skin. The injury had affected the fish further in that the mouth was prevented from closing completely, one side remaining partly open. However, the fish appeared to have had no difficulty in taking the bait and gave a battle said to have been entirely normal for a fish of its weight.

Farrington (1942: 110) reported numbers of marlin with spears broken off. This observation was made at Guaymas, Sonora, Mex-

ico. Grey (1926: 105) mentioned a marlin in New Zealand waters that had a broken spear. The region of the break is not indicated, nor is the amount missing. Grey states, "Deprived of his weapon of defense and for procuring food, this marlin might well have been expected to be thin, flat, in poor condition. Nevertheless, he was solid, fat, in splendid shape. He had been compelled to rely on his speed."

In September, 1952, the author examined two spearless striped marlin at the Marlin Club dock at San Diego, California. Each was captured with sporting tackle and trolled bait. Each spear had been broken off at about the tip of the lower jaw, as in Figure 1. Since both stubs had healed completely and were well covered with skin, a considerable time must have elapsed since the injuries. The fish weighed, respectively, 149½ and 186 lbs. (official club weight). These fish were of at least average weight for their length (Fig. 3). Morphometric data obtained on both specimens when compared with those of normal fish of the same body length and weight disclosed no significant differences in body proportions.

The stomach contents of the smaller fish comprised the remains of 8 Pacific sauries, *Cololabis saira* (Brevoort), totalling 349 cc. The larger fish contained 5 small yellowfin croakers, *Umbrina roncador* Jordan and Gilbert, totalling 785 cc., a small halfmoon, *Medialuna californiensis* (Steindachner), 105 cc., and 1 trunk section of a Pacific saury, 23 cc. The first fish had eaten a main item in the diet of local marlin, as determined by Hubbs and Wisner (1953), but its stomach contents were of less than average volume. The second had eaten more than an average amount, but chiefly of a shore species not otherwise encountered in the food studies.

A third spearless striped marlin was landed at the San Diego Club on September 17, 1955. This fish was not examined by the author, but was reported to have been normal in all respects and fought strongly. The stub was reported to be smoothly healed and covered with skin. A fourth spearless fish, landed in September, 1956, also was reported to be quite normal despite its loss of spear. This fish also was not examined by the author.

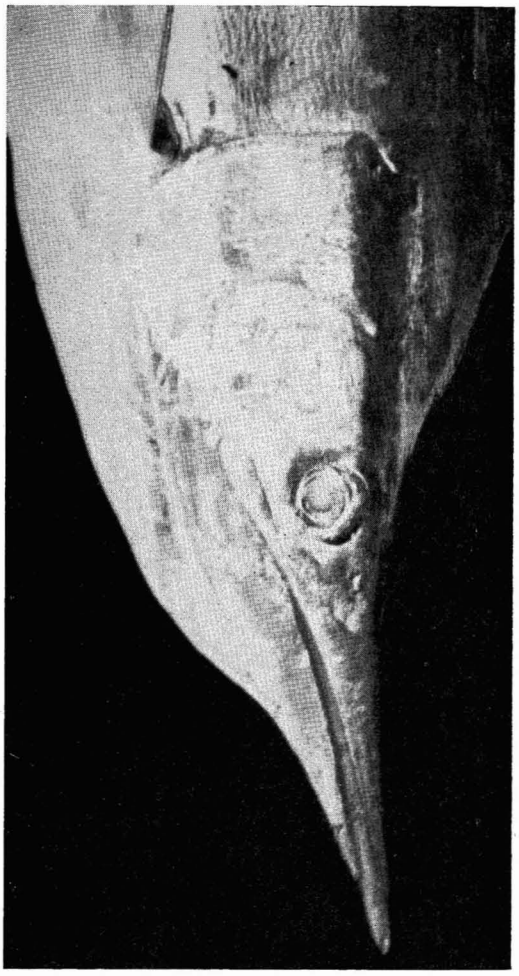


FIG. 1. Spearless striped marlin, weighing 149½ pounds. Photographed at the San Diego Marlin Club, Sept. 13, 1952, by R. Van Nostrand.

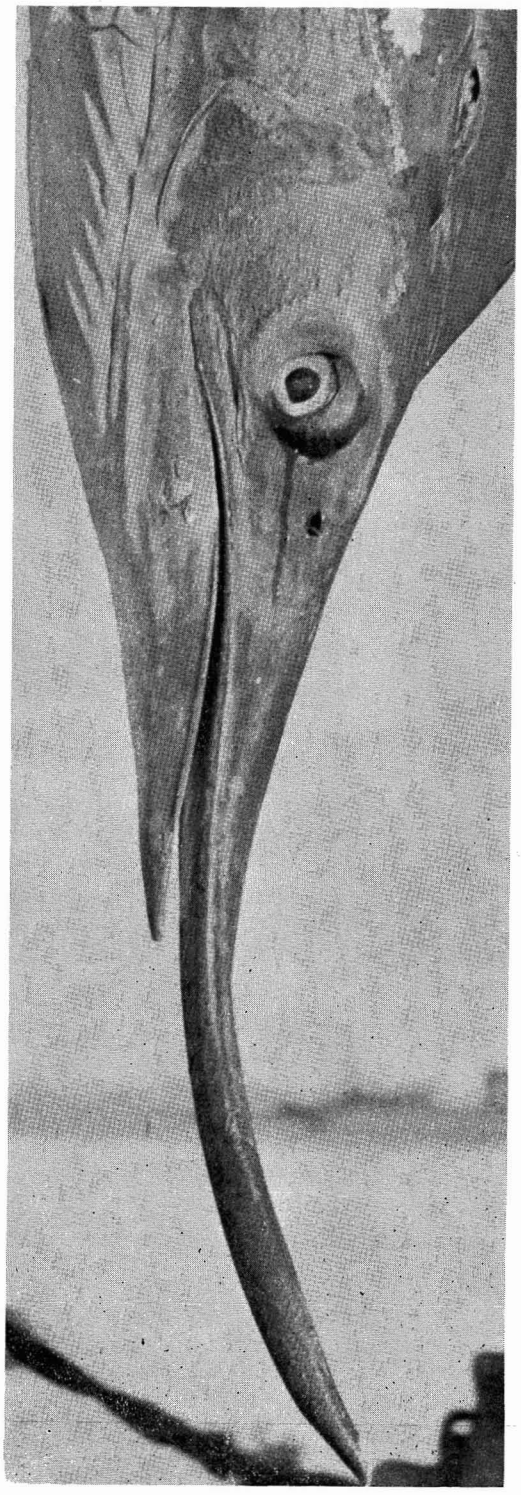
Gudger (1940) cited many examples of portions of spears having been broken off at a considerable period of time before capture. All these fish had apparently survived the wound and had flourished since. Unfortunately, most reports did not estimate the amount of spear missing. One account ap-

proaches the incredible. During the Michael Lerner Australian-New Zealand Expedition, Miles Conrad reported seeing a marlin with the spear sawed off, and yet the fish had survived. The spear had been removed by a square cut about midway between the tip of the lower jaw and the anterior edge of the eyes—the point generally selected for sawing off a spear trophy. The fish had evidently been caught by an angler, and, when the spear had been removed, had escaped to the ocean. The growth of skin that had formed over the stub still retained the rosy glow of healthy healing. The fish was reported to be thinner than a normal fish of its size. Without doubt a fish so injured as to leave the upper half of its mouth permanently open with but half an upper jaw would be seriously handicapped in feeding. The previously cited injuries had at least left the fish with mouths somewhat suited for grasping and holding prey.

As stated by Morrow (*op. cit.*), "It is obvious the spear is not absolutely essential to the well being of the spearfishes." The four specimens under the immediate cognizance of the author, as well as those reported by Moore, Morrow, Brock, and Gudger, had apparently existed in normal fashion despite the loss of the spear. None of those taken on sporting tackle had given any marked indication of weakness, or other abnormal behavior attributable to loss of the spear, while striking the trolled bait or during the ensuing battle.

RECORDED FEEDING AND BAIT-SEIZING HABITS

The fact that marlins can exist reasonably well without their spears reopens the question of how spearfish feed. Many anglers and authors of books on angling for the large game fishes have given accounts of spearfishes stunning their prey and trolled fish baits with a slashing blow, before turning to devour them. The angling methods for these fish have long involved a slack line arrangement to allow the bait to lie "dead" in the water following the initial rush or strike of the fish.



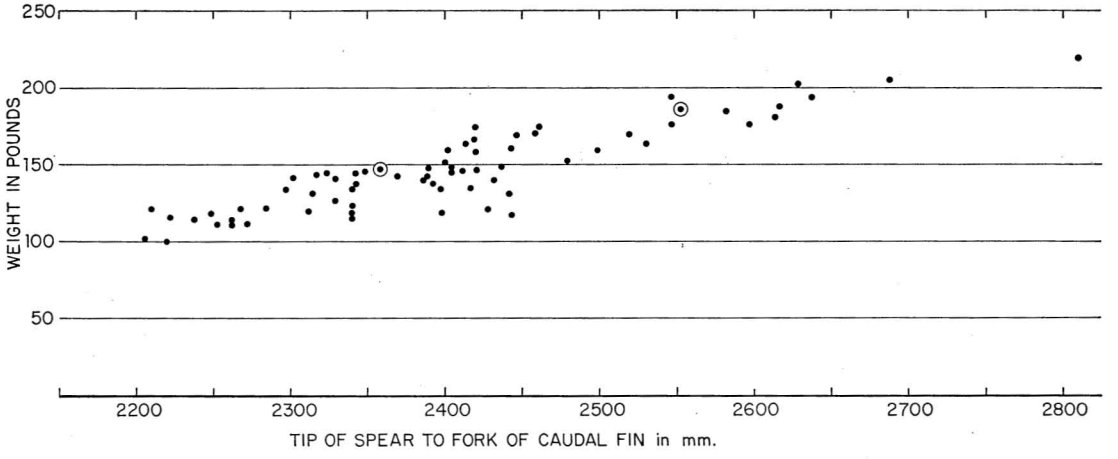


FIG. 3. Relation between weight and length from tip of spear to fork of caudal fin for striped marlin caught near San Diego in 1952. The two circled entries are for the two spearless fish caught that year. Their lengths are computed by adding the average length of spear from tip of mandible for other marlin of the same length behind tip of mandible. The two spearless fish are at least average weight.

According to Van Campen Heilner (1943: 108–109) almost no spearfish were taken in Florida waters before the discovery of this method by the famous Captain Bill Hatch of Miami, Florida, while experimenting with methods of taking sailfish. Heilner stated that Hatch, the father of the "Drop-back," came to the conclusion that, "When the sailfish first rushed the bait he struck it a blow with his spear to stun it and if it didn't collapse then and there, something was phoney. By immediately allowing a lot of line to run off the reel the sailfish was fooled into believing he had paralyzed his prey and would return to seize it." Prior to the use of this method the sailfish only mauled the fish being used as bait for kingfish and mackerel but could not be hooked, which may indicate that the sailfish were grasping the bait between their jaws rather than striking it with their spears and that the bait was pulled from their jaws or rejected before it could be swallowed.

It is known, of course, that marlin in particular do not always strike a blow before taking the bait. A fast rush and grab is most frequent. A hungry fish, of course, is much less apt to toy with a bait or prey than to make haste in consuming it. Thomas and Thomas (1930: 130) cited a fish that did not attempt to stun the bait with the spear. "The marlin changed direction in his rush and, just before he reached the lure he swerved to one side, as such fish nearly always do, and seizing his prey between his jaws, whirled, splashed a trifle, and, like a ray of light as he showed his gleaming underbody, turned downward and was away." In another connection (p. 122) these authors stated: "When marlin hit a troll they do not grab it in their mouths as do other fish; rather they seize it between their upper and lower bills before swallowing, and seem to approach the lure sideways, turning it before gulping it down." Bandini (1933) lent support to this opinion by stating, "A marlin seizes the bait crossways in his mouth and swims away with it."

In contrast to the foregoing testimony, Thomas and Thomas described the feeding habits of marlin as follows (p. 121): "They feed chiefly on anchovies, sauri [*sic*], sardines, flying fish, and other small fry, charging into schools of these unfortunates and slashing

FIG. 2. Striped marlin with a deformed spear. Photographed at Mazatlán, Sinaloa, México, Mar. 26, 1954, by R. L. Wisner.

right and left with their bills, before turning back and leisurely picking up those they have killed or crippled." Another report by these authors (p. 136) was that: "Marlin were everywhere, scattering bait and cutting the water with their fins and tails .... Terrified patches of bait skittered across the water endeavoring to elude their pursuers who slashed relentlessly."

Voss (1956) has contributed the following information. "How well the sailfish uses this weapon I discovered one calm winter day off Stuart, Florida, when we backed our boat into a school feeding on minnows. The sailfish circled slowly, sails half raised, herding their prey tighter and tighter. First one and then another broke from the circle and swam through the milling prey, thrashing right and left with their bills. Then the predators would submerge and lazily eat the dead and stunned minnows as they drifted down."

It is, of course, possible that a difference exists in the method of capturing trolled baits and free-swimming prey, even though the spearfishes may be facile in each method. One must give complete credence to such observations as made by Voss. It is evident that on occasion, abnormal though it may be, the spear is used to obtain food by thrashing. However, the mass of observations indicate this to be a rather infrequently employed method. The following observations from the field and from studies of stomach contents shed considerable light on the matter.

In examining the stomach contents of many marlin, the author has at times noted that the heads and pectoral regions of some of the less digested specimens had been severely damaged on both sides, presumably as a result of having been crushed between jaws. Along the same line Thomas and Thomas (*op. cit.*, p. 124) stated that "the bills [upper and lower jaws] of a marlin leave two distinct depressions on a small fish just behind the gills." These observations indicate that, at least at times, the struggling prey is seized so as to kill it, or to hold it firmly preparatory to swallowing it. The observations also indicate that in such situations the spear is not used to obtain food. If the prey had been killed or stunned or so injured as to prevent escape the marlin would not have needed to crush the prey before swallowing it.

That marlin can feed without the use of the spear is demonstrated by the following statement by Miss Francesca LaMonte of the International Game Fish Association (quoted by Hubbs and Wisner, 1953): "Dr. D. G. Maitland of Sydney, Australia, has recently written us as follows: 'It may interest you to know that I have actually watched a pair of Black Marlin feeding upon *Physalia*, like huge Rainbow Trout taking flies, and absolutely ignoring a most tempting looking mackerel bait drifting in front of their noses.' "

That prey much larger than the small coelenterate of the genus *Physalia* may be captured without obvious use of the spear is indicated by another observation. During preliminary studies of the food of striped marlin in the San Diego area in 1952, a young blue shark, *Prionace glauca* (Linnaeus), a little longer than 24 inches, was found in the stomach of a 205-pound marlin. This shark, which had been recently ingested bore no marks of a blow or thrust of the spear. A roughening of its skin over rather broad areas could have been produced by the sandpapery jaws of the marlin as it grasped and held the struggling shark. A blow, or blows, of sufficient force to kill or stun the notoriously hard-to-subdue shark would almost certainly have left identifiable marks on the body.

Still another indication of feeding that certainly would not call for use of the spear was encountered by the author while examining striped marlin stomach contents at Mazatlán, Sinaloa, México, in March, 1954. Both marlin and sailfish were feeding on a species of argonaut. Such a relatively slow-moving mollusk would be as easily captured as *Physalia* and would require not even the lightest tap from a spear.

Until very recently none of the studies of the food habits of marlin has disclosed any ingested fish that show the marks of having been slashed by or impaled on the spear. Hubbs and Wisner (1953), for example, found no evidence of fish having been damaged by the spear. A more definitive study of stomach contents for the 1952 and 1954 seasons in San Diego has substantiated these findings. Miss Francesca LaMonte (correspondence) states: "In no case have I ever seen anything that seemed to have been slashed by the spear or impaled upon it."

RECORDED USES OF THE SPEAR

The fact that the spear has been retained since possibly Upper Cretaceous, and certainly since Eocene times (Berg, 1940), indicates that it is much more of an aid than a hindrance to the fish. That the spear may, on occasion, be used to obtain food by stabbing, or as a weapon, is illustrated by the following observations. Anonymous writers (1955*a*, *b*) recorded that during a cruise into tropical waters south of Hawaii, "An interesting incident was the landing of a huge white marlin [*Istiompax marlina* (Jordan and Snyder)], estimated to have weighed around 1,500 pounds, which had in its stomach a freshly killed yellowfin tuna 5 feet in length and weighing 157 pounds. . . . The tuna had been speared clean through its body twice before being swallowed."

Another such observation from Hawaiian waters, again provided by Mr. Vernon E. Brock (correspondence), is as follows, ". . . the use of the spear to stab another fish does occasionally occur. One such observation by the skipper of the territorial research vessel was made off the Kona coast of Hawaii a number of years ago when a marlin was observed at the surface of the sea with its spear thrust through the body of a dolphin [*Coryphaena hippurus*]. The dolphin was struggling vigorously and the marlin would rear out of the water in an apparent attempt to prevent the flopping fish from working free of the spear."

Zane Grey (1926: 48) reported finding a snapper with a round hole in it in the stomach of a marlin caught in New Zealand waters. In Tahitian waters Grey (1931: 229) quoted Captain Mitchell, his fishing companion, as reporting his bonito bait rammed clear through by a marlin. Farrington (1937: 221) reported big dolphin "batted" into the air by marlin and that numbers of dolphin have been caught that had holes in them where marlin spears had pierced them.

This author has very recently studied a frigate mackerel, *Auxis* sp., and a sierra mackerel, *Scomberomorus sierra* Jordan and Starks, removed from marlin landed at Mazatlán, Sinaloa, México in March, 1954. These fish, respectively 300 and 430 mm. long, each bore the marks of a spear thrust through the midsection, respectively above and below the lateral lines. Each fish was removed by the author from undamaged, freshly caught striped marlin and wrapped and stored until studied. Unquestionably, the marks were made by spears as the holes were large and had been torn out through the dorsomedian flesh of the *Auxis*, and through the ventromedian flesh in the *Scomberomorus*. Several other fish of the same species groups and similar in body sizes bore no marks of the spear.

Gudger (*op. cit.*, pp. 271–274) cited several reports from reputable observers which indicate that battles occur between swordfish and spearfish, and between members of these two families and sharks. Broken spears have been found imbedded in the flesh of each, some obviously having been there for some time. Voss (*op. cit.*) reported catching a sailfish that had the broken bill of another sailfish projecting [through the body] on either side.

SPECULATION ON THE USES OF THE SPEAR

It seems probable that the spear is used both as an aid in food-getting and as a weapon. It is a rather moot question whether the cited stabbings and "battings" of larger fish

resulted from pugnacity, playfulness, or a desire to obtain food. The 157-pound tuna could conceivably have been regarded as an enemy by even a 1,500-pound marlin. The big dolphin would not seem to fit the enemy category although the relative sizes of prey and predator were not given. If it may be assumed that marlin customarily charge their prey to engulf it, it is then possible that the stabbings were accidental. If a spearfish is able to overtake its prey with sufficient speed to impale it, such speed should be more than adequate to permit the prey to be seized. Accidental stabbings of the smaller prey seem quite plausible if one considers the almost phenomenal accuracy required of the predator to hit and penetrate even an unsuspecting prey. In line with this view, impaling an evasive prey appears to be governed by chance. The few observations of stabbing make it seem possible that the spear may be used against the larger fishes—those not readily captured by overtaking and seizing between jaws.

The preponderance of evidence indicates the spear is not commonly used as a means of getting food. The food content studies to date have all dealt primarily with smaller forage animals. Presumably few others have been found. One must conclude that these comprise the bulk of the food of the spearfishes. As stated earlier, few indications of stabbing and none of injury by blows have been found. The prey had evidently been overtaken and engulfed by the predators. Those spearfish found with the spears missing had almost certainly employed this method of getting food.

Examination of the spear and jaws indicates that the smaller forage fish and squid, the prime components of spearfish food, could not readily be stabbed. The spear is relatively dull at the tip and is covered by minute, sharp, backward-pointing nodules for its entire length. These nodules continue to each jaw, where they become a raspy band of teeth. The roughness of the spear covering is attested by fishermen who almost invariably wear gloves to avoid having their hands abraded while the fish are being boated. It would be difficult indeed for the dull tip to penetrate small fish. Certainly the soft, flexible body of a squid would be extremely difficult to be impaled or to be dealt a damaging blow with so blunt a weapon. The swordfish has a smooth, laterally flattened sword of proportionately greater length than that of the spearfishes, but it is equally blunt at the tip. It is better suited as a flail but no better suited for spearing small prey. A striped marlin poorly suited for stabbing prey was observed by the author at Mazatlán, México, 1954 (Fig. 2). The curve of its spear was such that a thrust would tend to slide off a relatively small fish.

Further evidence that the spearfishes do not commonly slash with their spears is found in their skeletal make-up. The construction is not suited to free and extensive sidewise motion. The istiophorids have heavy, flat, platelike neural and hemal spines rather than the common rodlike spines of other fishes. The neural processes are modified into broad platelike structures that extend far forward, almost reaching the middle of the preceding vertebra. The platelike hemal spines are firmly attached to the hemal processes of the neighboring vertebrae, as are the neural spines and processes. Such construction produces an exceptionally strong and inflexible, interlocking, bracing system. The vertebral column of the broadbill is less interlocked but is so fashioned as to resist greater shock from head-on encounters than is that of the spearfishes.

Nakamura (1938), who studied the skeletons of many spearfishes, concluded that "The vertebrae are most unsuited for precise movements, and sudden changes of direction are probably impossible." Furthermore, the deep and flat lateral surface of the anterior part of the body would require tremendous energy and leverage against the resistance of the water to accomplish a slashing movement

sufficiently rapid to strike a small fish fleeing for its life. Such great expenditure of energy would detract from the forward speed of the spearfish, bringing it to a virtual standstill and allowing the prey to escape with but little damage.

It is more reasonable to assume that when a spearfish charges into a school of forage fish the slashing motion observed by many fishermen is really a slight changing of direction and a grasping for the fleeing prey, the head and body describing a relatively small arc. Such a grasping motion is not be to identified with any such deliberate slashing as Voss (*op. cit.*) reported for sailfish. In his observation the prey was herded into a tight school. The speed of the predators was not mentioned. They merely swam into the closely packed school, held together by the remaining sailfish (of unreported number), and thrashed with their spears. Presumably all energy could be utilized solely to kill fish rather than be expended in pursuit.

It must be assumed that spearfish are not always able to concentrate their prey in such fashion. In a less dense and guarded school of prey, and certainly in a very scattered school, it would not be advantageous to merely slash. It is entirely possible that the normal procedure is to charge into the school rapidly snapping the jaws and reaching, within physical limits, for as much prey as possible, with the result that many of the small fish are killed or wounded before the school scatters. Any effective striking with the spear that may occur is probably a secondary and fortuitous event. After the school has scattered the spearfish would likely see the wounded or killed fish and would return to ingest them.

These large fishes are obviously built more for forward speed than for marked agility. It is entirely within reason to assume that a spearfish can readily overtake any of the forage fishes or squid, which constitute the bulk of its food, and most of the larger fishes. A conservative estimate of their speed is at least 25 miles per hour and bursts of much greater speed are probable. A hooked sailfish was clocked at 100 yards in three seconds, or approximately 68 miles per hour (Walford, 1937).

The enormous speed and power of spearfish are dramatically attested by the puncturing of ship hulls. Gudger (1940) reported, with documentation and photographs, many spears found in wooden and copper-clad hulls of vessels. Some of these had penetrated fantastic thicknesses of timber and had broken off to furnish irrefutable evidence of speed and power. One remarkable example follows: "The spear was found to have penetrated through the copper sheathing, an inch board sheathing, a three inch hard wood plank, the solid white oak timber of the ship 12 in. thick, through another two and a half inch hard oak ceiling-plank, and lastly had perforated the head of an oil cask, where it remained immovably fixed so that not a single drop of oil had escaped." This total of 18.5 inches through hardwood, 14.5 of it through dense oak, was accomplished by a spearfish as the recovered spear was round, unlike the flattened blade of the broadbill swordfish.

San Diego based wooden-hulled fishing vessels have at times been placed in danger of sinking by these fish. The tuna vessel "Rose Ann" (San Diego Union, 24 Oct., 1946) was struck three feet below the water line off Punta Abreojos, Baja California, and was forced to use both bilge pumps constantly to remain afloat. Subsequent investigation revealed five inches of marlin spear projecting through the hull planking. Fishermen recalled that other vessels in 1942 and 1946 had suffered the same type of damage. Another recorded ramming occurred off Ecuador, involving the tuna vessel "Renown" (San Diego Union, 22 Aug., 1948). Pumps were operated continuously during the homeward voyage. When the hull was inspected 18 inches of marlin spear was found projected through the 3-inch hull planking, forming a crack an inch wide.

There are further indications of the speed and power of marlin, and possibly of their pugnacity. Morrow (1951) reported having seen on a beach in British East Africa a bale of crude rubber that held the broken spear of a black marlin imbedded 8 or 10 inches into rubber so tough a man could not drive a spike into it with a heavy hammer. Smith (1956) reported on floating rubber bales from the African coast. As many as four spears have been found in one bale. Another bale contained 24 inches of the spear of a large black marlin embedded to a depth of 13 inches. In one bale was found the sword of a broadbill swordfish, indicating that it also charges floating objects.

The reasons for these attacks are not completely understood. Some may be the result of sheer pugnacity. However, it has long been known that fish often lie beneath floating logs, debris, ship hulls or any fairly large, slowly moving object at or near the surface. The tuna live-bait fishermen make a practice of fishing, often with considerable success, close to such objects, including the large whale shark, *Rhineodon typus* Smith. The ramming of ship hulls may well be the result of excess speed and a lack of maneuverability of the attacker as it charges to engulf fish lying under such shelter.

Gudger (*op. cit.*) supported this view with an observation by F. D. Bennett (Narrative of a Whaling Voyage Round the Globe, 1833 to 1836, London, 1840). Bennett tells of albacore [*sic*], clustering in a dense shoal under the ship, that "swam with an appearance of trepidation and watchfullness. The cause of this unusual commotion was visible in a swordfish, lurking astern, awaiting a favourable opportunity to rush upon his prey when they should be unconscious of danger or away from the protection of the ship. . . . and in the course of the day we observed him make several dashes amongst the shoal with a velocity which produced a loud rushing sound in the sea. . . . It is probable, as a precaution against the attacks of this monster, that albacore, and some other tropical shoal fish, attach themselves to ships, . . . , the close vicinity of a large body being sufficient to deter the swordfish from making his usual impetuous thrusts amidst the shoal; the which, when rashly attempted, have given rise to the appearance of the broken rostra of these fish impacted in the planks of ships, . . . as is not unfrequently noticed." Although the name "swordfish" is used it may also have been a member of the round-speared Istiophoridae, as all were termed swordfish until recent years.

Certainly no flailing at prey could have resulted in such penetrations of hulls as recorded. The angle of incidence of spear and hull would either have deflected the spear or have caused only slight penetration. Also, if the spearfish had concentrated on a side-to-side motion, the greater portion of the total energy would have been expended in this action. The forward speed would have been correspondingly reduced, so as to lessen the depth of penetration, regardless of the angle of incidence. Only a straight-forward charge resulting from pugnacity or an attempt to capture prey could result in such penetrations.

The biological significance of the spear may well be an adaptation for the great speed and power of these large fish, as well as a weapon of defense or attack. I am indebted to John D. Isaacs and Carl L. Hubbs for the following suggestions. A terminally opening mouth would create enormous drag and would push in front a mass of water at a similar speed, so that a spurt of the intended prey would lead it to safety. If the mouth were terminal the common mode of ingestion by suction due to a sudden spreading of the gill covers as the mouth is opened would probably be difficult and perhaps dangerous at extreme speeds. On the other hand the projecting and tapered spear would scarcely impede the flow of water past the narrowly triangular mouth on the lower surface of the base of the beak. A sudden snapping of the sharply pointed inferior mandible would induce minimal drag and would be effective in

grasping prey. If the spear is of use in feeding, it is probably of most value in permitting high speeds to be attained by the feeding fish.

It may be argued that the tunas and porpoises are also rapid swimmers yet have terminally opening mouths. However, they too are well streamlined and have relatively narrow snouts that no doubt induce minimal drag at high speeds. Indeed, their spearless heads may be considered analagous to those of spearfish without spears. There is little doubt but that the tunas and porpoises rely on speed to capture prey.

SUMMARY AND CONCLUSIONS

It is concluded that the spearfishes rely primarily on speed to overtake and engulf their food. This circumstance explains why spearless marlins are able to obtain food and to exist in competition with their undamaged fellows. The widely held belief that these fishes, marlins in particular, normally stun prey with a blow of the spear has presumably stemmed from fishermen watching fish turn slightly to grasp the bait between jaws or to engulf it, during which action the spear performs a lateral motion readily interpretable as a slash or blow. The several instances of stabbings of prey may well have resulted from the high speed of the predator and escape attempts of the prey, the spear point inadvertantly striking the prey. There is little to indicate that most stabbings are intentional. In the face of preponderant evidence that most of the prey is not stabbed, one must, for the present, accept the probability that such spear penetrations are quite accidental.

Further evidence that these fishes rely on speed to overtake prey are the numerous accounts of the ramming of ship hulls and floating objects. It seems logical to assume that many such rammings result when spearfishes charge prey lying under these vessels and either fail to see the hull or misjudge the distance between prey and hull. The depths of penetration strongly indicate that the spearfish was not using its spear as a flail to obtain food. Such penetrations of objects could have resulted only from a straight-forward charge, either to seize the prey lying underneath or to battle a fancied enemy.

The restrictions in rapid lateral movement imposed by the highly integrated and reinforced vertebral column render it highly improbable that such fishes normally kill or stun prey by slashing with their spears, particularly when in pursuit of fleeing prey. The roughened surface of the spear and its relatively blunt tip preclude the possibility of stabbing the smaller fishes and the squid, which comprise the major food items of the spearfishes.

In whatever way it is used, the spear presumably serves a hydrodynamic function, increasing the speed of these large fishes. In feeding it presumably does more. The form of the spear and of the adjacent parts of the head seem well fitted to avoid drag, escape of prey, and possible injury at high speeds when the mouth is opened. A rapid water flow is induced past the mouth region, and the mouth appears to be so formed as to present minimal resistance when closed and but slight resistance when opened to seize prey.

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